PART TITLE: WVDP WASTE FORM QUALIFICATION REPORT - CANISTERED WASTE FORM SPECIFICATIONS

ITEM TITLE: SPECIFICATIONS FOR WEIGHT AND OVERALL DIMENSIONS

3.11 Specifications for Weight and Overall Dimensions[1]*

The configuration, dimensions, and weight of the canistered waste form shall not exceed the maximum size and weight which can be received, handled, and emplaced in the repository. These parameters shall be controlled as indicated below and shall be documented at the time of shipment. The producer shall describe the method of compliance in the WCP and the basis for compliance in the WQR.

3.11.1 Weight Specification

The weight of the canistered waste form shall not exceed 2,500 kg. The measured weight and estimated error shall be reported in the Storage and Shipping Records.

3.11.2 Specification for Overall Dimensions

The dimensions of the canistered waste form shall be such that, at the time of
FC1> **delivery, the canistered waste form will stand upright without support on a flat horizontal surface and will fit completely without forcing when lowered vertically into a right-circular cylindrical cavity, 64.0 cm in diameter and 3.01 m in length. The producer shall estimate in the WQR the minimum canister wall thickness of the filled, decontaminated canister. The producer shall also provide in the WQR an estimate of the amount of canister material that is removed during surface decontamination and the basis for that estimate. The producer shall document the unfilled canister wall thickness in the Production Records.**

WVDP COMPLIANCE STRATEGY

The glass filled canisters will be weighed and the errors estimated before shipment to the repository.

Canisters filled during non-radioactive testing and during production at West Valley will be inserted into a test cylinder with dimensions, at most, those given in the specification. The minimum canister wall thickness will be determined from ultrasonic measurements taken on canisters filled during non-radioactive FACTS runs minus the 304L material loss due to the WVDP decontamination process. Ultrasonic wall thickness measurements on the as-manufactured, production canisters will be made.

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* The specification, as provided in Reference 1, is reproduced here in bold face print.

IMPLEMENTATION

Canister Weight

The weight of the canistered waste form is a function of the as manufactured weight of the empty canister and the glass fill height. The design specifications for the as manufactured canister have been carefully selected so that even if the canister is filled to 100% capacity, the weight of the canistered waste form will still be well below the 2500 kg specification. Based upon measurements taken during the non-radioactive FACTS (Functional and Checkout Testing of Systems, 1984-1989) program, the weight of a canister filled to the 85% level will be about 2100 kg, as shown in Table 1. It is estimated that a 100% glass filled canister will weigh approximately 2400 kg.

During the non-radioactive FACTS program, a crane hung dynamometer was used for weighing canisters at the WVDP. A similar weight measurement system having a maximum capacity of 5000 kg with an accuracy of ± 1.0% will be used to weigh radioactive canisters. The precision (standard deviation) of the dynamometer will be determined from three measurements on each canister. The total measuring error of the dynamometer will be estimated from the square root of the sum of the squares of the accuracy and the precision. The measured weight and the estimated error will be reported in the Storage and Shipping Records.

Overall Dimensions for the Canistered Waste Form

The length, diameter, and wall thickness will be controlled by means of the canister equipment specification[2] and contract drawings[3,4] (see WQR Section 2.2) which require the fabricator to ensure that canister length be 3.000 m (+ 0.005 m, - 0.020 m), diameter be 61.0 cm (+ 1.5 cm, - 1.0 cm), and the cylinder's barrel component be 10 gauge 304L stainless steel (0.1345 ± 0.0120 inch thickness). The validity of this approach to maintaining canister dimensions within those required by this specification is based upon experimental measurements taken during the FACTS program demonstrating that molten glass filling does not significantly affect the dimensions of the canistered waste forms. Table 2, which compares prefill and postfill canister dimensions from the FACTS SF-12 run, confirms this assessment.

Experimental measurements taken during FACTS SF-12 also indicated that the canister does not deform or bow significantly when filled with molten glass. The method used to obtain the canister diameter measurements in Table 2 showed this. The canisters, both before and after filling, were lowered into a canister envelope cylinder having an inside diameter of 63.5 cm and length of 300 cm, dimensions that are more restrictive than this requirement. All canisters stood upright on the flat surface at the bottom of the envelope cylinder without any part of the canister contacting the walls of the envelope. Four columns of 13 port holes, each column 90° from the next, were drilled every five to ten inches from top to bottom along the length of the envelope cylinder. Through these port holes a micrometer gauge was inserted and the distance to the outer surface of the test canister inside measured. The outside diameter of each canister was derived by subtracting the sum of the micrometer measurements from the known outside diameter of the envelope cylinder. The data in Table 2 represents an average of all diameter measurements for each canister.

TABLE 1[6]

SF-12 CANISTERED GLASS DATA

Canister #	Empty Weight (kg)	Total Weight of Glass only (kg)	Weight of Canister and Glass (kg)	Calculated* Percent Filled
41A	181.4	1859.7	2041.1	86.0
44A	181.4	1877.9	2059.3	83.9
47A	181.4	1723.7	1905.1	84.0
57A	181.4	2097.9**	2279.3**	85.0
65A	181.4	1769.0	1950.4	86.5
66A	181.4	2131.9	2313.3	92.2

* Based on the fill height data (Table 2, WQR Section 3.6) and the fill height equation in WQR Section 3.6.

** These weights fail to compensate for the ~200 kg tare weight of the canister handling grapple.

TABLE 2[6]

SF-12 CANISTER DIMENSIONAL TEST RESULTS

Canister #	Length (cm)*		Outside Diameter (cm)**	
	Prefill	Postfill	Prefill	Postfill
41A	299.40	299.40	60.90	60.95
44A	299.40	299.40	60.89	60.89
47A	299.40	299.32	60.78	60.85
57A	299.09	299.09	60.88	60.90
65A	300.04	299.72	60.89	60.93
66A	300.04	299.72	60.87	60.99

* Represents the average of four length measurements per canister

** Represents the average of twenty-six diameter measurements per canister

Wall Thickness of the Canistered Waste Form

The two possible effects which could reduce the wall thickness of production canisters have been investigated. These effects are corrosion due to contact with the molten glass and wall thickness losses during the decontamination process.

Ultrasonic measurements of several canisters taken prior to and after filling during the non-radioactive FACTS program indicated little, if any, decrease in wall thickness due to contact with molten glass (see Table 3). Virtually no corrosion was detected within the ± 0.001 inch accuracy limit of the instrument used. The ultrasonic measurements were taken at eight different locations along the body of each canister. At each location, a 5 inch x 5 inch grid was inscribed. The grid was subdivided into 1/2 inch x 1/2 inch squares, for a total of 100 measurement points for each grid*, or a total of 800 for each canister. Measurements were taken for each canister both before and after filling.

To assess the effect of the Ce^{+4} decontamination process (Section 3.7) on canister wall thickness, both laboratory scale and full-scale uncontaminated glass-filled canister surface cleaning experiments were conducted. These experiments were based upon a study (Bray, 1988[5]) which indicated that a thin layer (approximately 3 to 6 µm) of oxidized stainless steel metal surface could be effectively removed from 304L coupons through chemical milling with 0.5 M to 1 M HNO_3 solution containing approximately 1.4 to 2.7 moles of Ce^{+4} per square meter of surface area. Chemical milling for 6 hours at 65°C was sufficient to reduce the radioactive gamma contamination to levels below the WAPS requirements as discussed in WQR Section 3.7. During production, the Ce^{+4} decontamination solution concentration and/or exposure time will be controlled to remove the contamination and an amount of stainless steel within the 3 to 6 µm range.

Based upon the sum of thickness tolerances for 10 guage 304L stainless steel (0.1345 ± 0.0120 inches), and expected canister wall thickness reduction due to corrosion (approximately 0.001 inch maximum) and the Ce^{+4} decontamination process (6 µm or approximately 0.0002 inch), the expected minimum wall thickness for production canisters will be 0.1213 inch.

Overall Dimensions of Production Canisters

WVDP will procure a stainless steel cylinder gauge with an inner diameter and length at most 64.0 centimeters and 301 centimeters, respectively. All radioactive waste canisters will be inserted into this test cylinder before shipout to verify that the canister fits without forcing and meets the maximum dimensional specifications. Before insertion into the shipping casks, the waste canisters will be placed on a flat, horizontal surface to assess their ability to stand upright. The unfilled canister wall thickness will be ultrasonically measured at the canister fabricator's facility.

*** Measurements were taken at the center of each square in the grid.**

TABLE 3[7]

CANISTER WALL THICKNESS TEST RESULTS

Canister #	Grid Location*	Average Wall Thickness (inches) Prefill	Postfill	Difference (inches)
41A	ALL	NR	NR	--
44A	A	0.134	0.134	0.000
	B	0.134	0.134	0.000
	C	0.139	0.139	0.000
	D	0.139	0.139	0.000
	F	0.138	0.138	0.000
	G	0.138	0.138	0.000
	H	0.133	0.133	0.000
	E**	0.211	0.211	0.000
47A	A	0.131	0.134	0.003
	B	0.131	0.134	0.003
	C	0.137	0.139	0.002
	D	0.137	0.139	0.002
	F	0.136	0.138	0.002
	G	0.137	0.138	0.001
	H	0.133	0.135	0.002
	E	0.206	0.209	0.003
57A	A	0.131	0.131	0.000
	B	0.133	0.132	0.001
	C	0.138	0.138	0.000
	D	0.139	0.138	0.001
	F	NR	0.138	-----
	G	NR	0.138	-----

TABLE 3[7] (Continued)

CANISTER WALL THICKNESS TEST RESULTS

Canister #	Grid Location*	Average Wall Thickness (inches) Prefill	Postfill	Difference (inches)
	H	NR	0.131	-----
	E	0.214	0.200	0.014**
65A	A	0.139	0.138	0.001
	B	0.139	0.138	0.001
	C	0.139	0.139	0.000
	D	0.139	0.138	0.001
	F	0.137	0.138	0.001
	G	0.138	0.138	0.000
	H	0.137	0.138	0.001
	E	0.181	0.168	0.13**
66A	A	0.139	0.140	0.001
	B	0.140	0.139	0.001
	C	0.138	0.138	0.000
	D	0.138	0.138	0.000
	F	0.137	0.139	0.002
	G	0.139	0.138	0.001
	H	0.138	0.138	0.000
	E	0.193	0.192	0.001

* Grids B and H are located about 45 inches below top of canister and are 180° apart, grids C and G located about 69.5 inches below (180° apart), grids D and F located about 94.5 inches below (180° apart), grid A located about 7.5 inches below top, and grid E, located 114.5 inches below top, wraps around curve of bottom head

** Grid E (canister bottom) data is unreliable because of the difficulty in assuring that the ultrasonic transducer is perpendicular to the canister surface since the bottom head of the canister has a radius of curvature

NR No data recorded

DOCUMENTATION

The measured weight of the canistered waste form and estimated error will be reported in the Storage and Shipping Records. The as-built dimensions including the wall thickness for each unfilled canister will be entered into the Production Records. The Storage and Shipping Records will document all canister test results from the overall dimensions (cylinder) test and the upright stand test.

REFERENCES

| †1. Waste Form Compliance Plan for the West Valley Demonstration Project High-Level
FC1} Waste Form (WCP), WVDP-185.

| †2. Equipment Specification for WVNS HLW Production Canister and Lids, WVNS-EQ-382, Rev. 1, June 1994.

| †3. High-Level Waste Production Canister Assembly and Details, Drawing No. 900D-5743, Rev. 1, June 1994.

| †4. High-Level Waste Production Canister Lid Details, Drawing No. 900D-5744, Rev. 1, June 1994.

| †5. WVNS-DP-028, Rev. 1, 1995, "Development of Ce(IV) Decontamination Process,"
| containing PNL report: Bray, L. A., "Development of a Chemical Process Using Nitric Acid-Cerium (IV) for Decontamination of High-Level Waste Canister," PNL-6567, Pacific Northwest Laboratory, June 1988.

| †6. WVNS-DP-013, "SF-12 Data for Canister Weight, Dimensions, and Fill Height",
| Rev. 1, 1996.

| †7. WVNS-DP-017, "Wall Thickness Data for WVNS Canisters Used in SF-12 Campaign",
| Rev. 1, 1996.

| † These references are required to demonstrate conformance with the WCP
| compliance strategy.

WVNS RECORD OF REVISION

Rev. No.	Description of Changes	Revision On Page(s)	Dated
0	Original Issue	All	09/19/94
1	Revision made per Technical Review Group comments (reference letter DW:95:0534).	2,3,4,5	08/14/96
	Identification of key references.	8	
FC1	Updated Specification to be consistent with current revision of WAPS.	1	10/03/01
	Deleted revision number and date from Reference 1.	8	
	Moved Tables 1-3 to be in line with text they are referenced in.	3,4,6,7	
	No departments are impacted by this change		
	Repaginated document to allow for field change.	All	

WVNS RECORD OF REVISION CONTINUATION FORM

Rev. No.	Description of Changes	Revision On Page(s)	Dated